Low Energy Beam Transport (LEBT)

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LEBT

The Low Energy Beam Transport (LEBT) transports the beam from the EBIS and matches it to the RFQ. The layout was shown in Fig. 3.1. The LEBT is 1.5 meters long and consists of extraction/ acceleration system, grid lens and a solenoid magnet for transverse matching, two sets of transverse steerers, and a Y-chamber in the middle of the line. One arm of this chamber allows ions from an external ion source to be injected into the EBIS trap. In the second arm extracted ions can be deflected into a time-of-flight diagnostic. The grid lens is used instead of solenoid to allow inject ion into EBIS from external ion source via a spherical lens into LEBT. Since the focusing requirement of extracted ion and injected ions are much different, it is much easier to change voltage on grid lens than current in the solenoid in order of 5 ms.

The beam from the EBIS source has to be matched into the RFQ, which needs a small, highly convergent beam. The beam out of EBIS is symmetric in x and y, as is the RFQ acceptance, so one needs control of only two degrees of freedom for matching. Figure 3.2.1 shows particles trajectories through extraction/ acceleration system and grid lens. Figure 3.2.2 show beam envelopes along the last part of LEBT (output from TRACE code). Table 3.2.1 shows the Twiss parameters at the beginning, middle and end of the LEBT for ion Au^{+32}.

The magnetic fields required for the two transverse matching solenoids are 4 and 7.5 kG. There is about 1 meter between these two solenoids for the ion injection and diagnostics.

Table 3.2.1: Twiss parameters at beginning and end of the LEBT.

Parameters	**Beginning of LEBT**	**Middle of the LEBT**	**End of LEBT**	**Units**
α_x	-5.3	2.02	1.057	
β_x	0.800	6.04	0.0639	mm/mrad
ε_x (4*rms,unnorm)	152	125	125	π mm mrad
α_y	-5.3	2.02	1.057	
β_y	0.80	6.04	0.0639	mm/mrad
ε_y(4*rms, unnorm)	152	125	125	π mm mrad

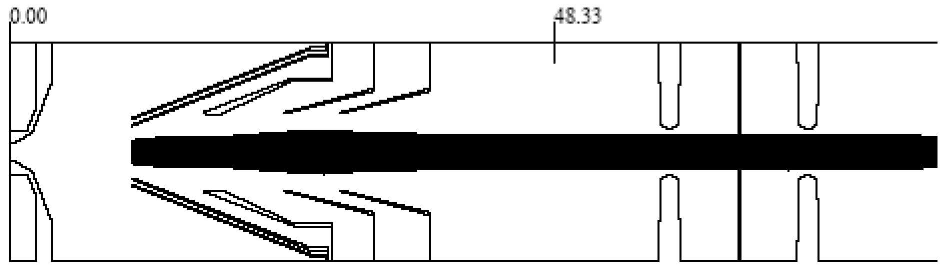

Figure 3.2.1 Particle (Au^{+32}) trajectories through extraction/ acceleration and grid lens.

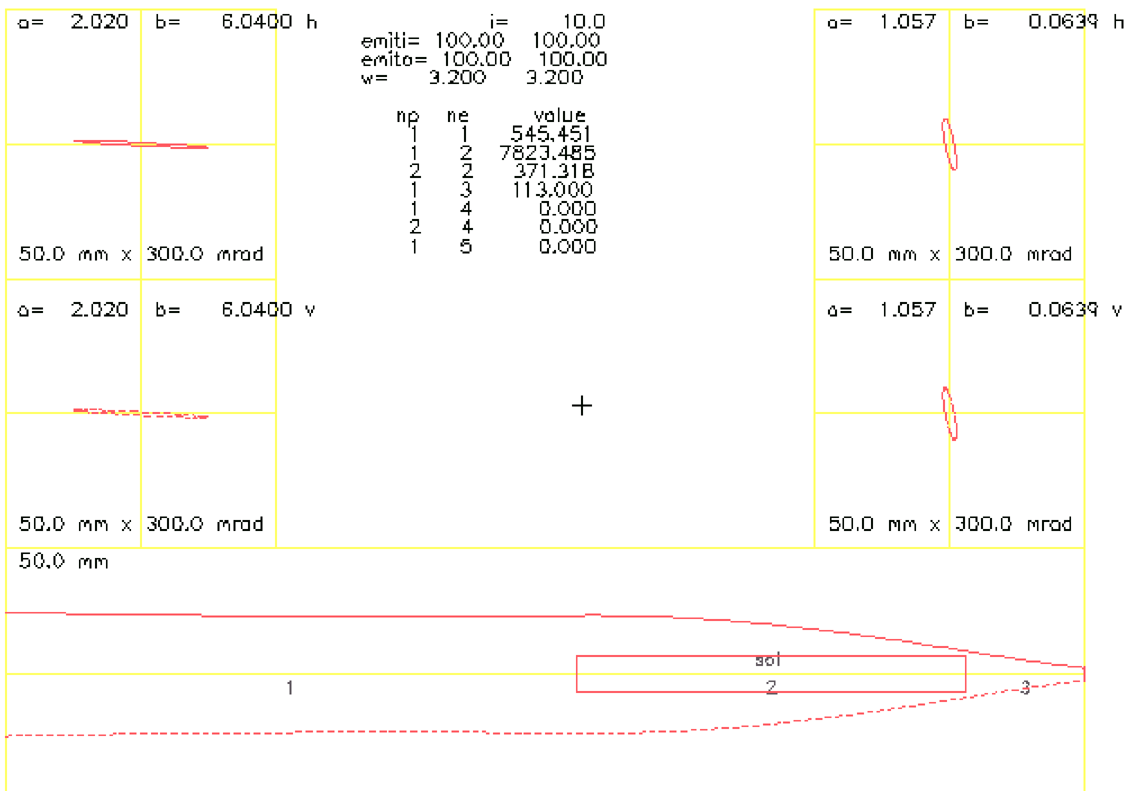

Fig. 3.2.2. TRACE output showing beam transport from EBIS to RFQ

These calculations have been done including the effects of the space charge at the full beam current of 10.0 mA (all charge states), since the pulse length is too short for neutralization to occur. If the charge-state distribution were broader, as in an ECR or LIS, the space charge from a much higher total beam current would present problems in matching. Simulation for extraction/ acceleration system and grid lens was done using axial symmetric code AXCEL and rest of the LEBT was simulated with TRACE. Trable 3.2.2 shows the beam parameters for different charge at the entrance of the RFQ. Figure 3.2.3 show the phase space ellipse at the entrance of the RFQ.

Table 3.2.2. Beam parameters for different charge states of Au at RFQ entrance.

Au Charge State	Energy (MeV)	Curr. (mA)	Trans. (%)	X_XP			Y-YP		
				α	β	ε	α	β	ε
32	3.2	10.0	100	1.057	0.0639	125	1.057	0.0639	125
31	3.1	10.0	100	0.994	0.0631	125	0.994	0.0631	125
30	3.0	10.0	100	1.111	0.0942	125	1.111	0.0942	125
33	3.3	10.0	100	1.118	0.0572	125	1.118	0.0572	125
34	3.4	10.0	100	1.432	0.119	125	1.432	0.119	235

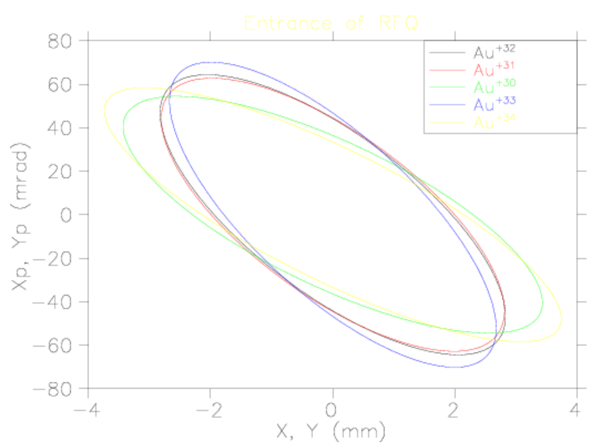

Figure 3.2.3 Phase space ellipses for different charge states of Au at entrance of RFQ.

Calculations have also been done where the beam is matched into the RFQ with both solenoid lenses, and this is still a viable option that is being considered.